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Simulations of ground motion in the Tehran basin based on newly developed 3D velocity model

Saeed Soltani[1,2], Cecile Cornou[3], Bertrand Guillier[4], and Ebrahim Haghshenas[5]

[1]Ph.D. Student, Univ. Grenoble Alpes/CNRS/IRD/IFSTTAR, ISTerre Grenoble, France (saeed.soltani@univ-grenoble-alpes.fr)
[2]Ph.D. student, IIEES, Tehran, Iran (s.soltani@iiees.ac.ir)
[3]Ph.D., Univ. Grenoble Alpes/CNRS/IRD/IFSTTAR, ISTerre, Grenoble, France (cecile.cornou@univ-grenoble-alpes.fr)
[4]Ph.D., Univ. Grenoble Alpes/CNRS/IRD/IFSTTAR, ISTerre, Grenoble, France (bertrand.guillier@ird.fr)
[5]Ph.D., IIEES, Tehran, Iran (haghshen@iiees.ac.ir)

Tehran urban area serves as the main hub for economic and social activities in Iran. The city is located on a sedimentary basin including faults and folds, and thus it is vulnerable to large site effects. Analysis of earthquakes recorded by a temporary seismological network has approved a large amplification of seismic ground motion (about 4 to 8) over a broad frequency range.

In order to better understand and predict the effects of the geometry and mechanical properties on surface ground motions, we developed a 3D shear-wave velocity model of Tehran by integrating extensive geophysical surveys including almost 600 single station measurements and 33 ambient vibrations arrays, with geotechnical and geological data. This 3D model shows that the bedrock depth varies between 100 and 900 meters with a general increasing depth from N-NE toward the S-SW. Also, there are two main velocity layers in the basin. A surface layer, which drops from 950 m/s to 600 m/s from NE to SW and a deeper layer with Vs up to 1300 m/s.

We then used the open-source spectral-element code, EfiSpec3D (DiMartin et al., 2011), to simulate ground motion by this new sedimentary basin model at the defined 50*50 kilometers tilted square simulation block up to the maximum target frequency of 2 Hz. The source time function is a 2-Hz lowpass filtered Dirac impulse injected from the defined z-plane at 5 km depth.

The results reveal a good correlation between real and simulated earthquake ground motion by the comparison between experimental and synthetic standard spectral ratios (SSR). The results also reproduced the experimental H/V frequency peaks over the basin relatively well and suggest that 3D geometry always should be considered for an accurate estimation of realistic basin response.